GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

15130/8005

Date 6-20-67

Purpose: To determine operability and yield with 4 x 2½ inch shale using hot dilution gas.

GENERAL	R-1
Run No.	C1046-3
Length, hours	12
Retort Type Number	RC VII
Oil Recovery System Number	C-1
Tons Total Raw Shale Charged, ~~lbs.~~	100.08
Bed Height above Dist., ft	9½
Type Air Dist.	AD XI
Bed Below Air Dist., ft	6
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft²)	302
Spent Shale, % of RS	81.7
Liquid Product, lbs/hr	170.69
Oil Collected, gal/ton RS	23.9
Air, SCF/ton RS (dry)	5080
Total Recycle*, SCF/ton RS(wet)	12800
Dilution, SCF/ton RS (wet)	1950
Calc. Vent Gas SCF/ton RS(dry)	6350
Gas Losses, SCF/ton RS(wet)	676
Propane, SCF/ton RS	15.2
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	138
Spent Shale, F	636
Raw Shale, °F	81
Recycle Gas Inlet, °F	265
Dilution Gas Inlet, °F	271
Air Inlet, °F	137
Retort Air Inlet, F	137
Heat of Comb. MBtu/ton RS	477
Heat Lost, MBtu/ton RS	-7
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	28.1
Oil, Wt %	10.7
Water, Wt %	0.98
Gas, Wt %	2.2
Mineral CO_2, Wt %	17.1
Ash, Wt %	67.2
Moisture, Wt % (Uncrushed)	1.25 Est.
Carbon (Total), Wt %	17.7
Hydrogen (Total), Wt %	1.75
Nominal Size Range, inches	¼"-2½"
5 % passing thru	0.525
98 % passing thru	2.50
D_a	1.760
D_v	1.691
Line Burner °F	700

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.0
Mineral CO_2, Wt %	15.1
Ash, Wt %	82.3
Carbon (total), Wt %	6.35
Organic Carbon, Wt %	2.23
Hydrogen (total), Wt %	0.14
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	98.4
Density, lb/gal	7.742
Gravity, API	20.7
Ash, Wt %	—
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF(dry)	5.3
Oil, lbs/MSCF(dry)**	0.094
Analysis (dry)	
CO_2, Vol %	24.3
O_2, Vol %	0.5
N_2 + Argon, Vol %	63.3
CH_4, Vol %	2.0
CO, Vol %	3.0
H_2, Vol %	5.3
Other, Vol %	1.6
Gross Heating Value(calc),Btu/SCF	95.8
Carbon (Total), lbs/MSCF (dry)	11.6
Hydrogen (Total), lbs/MSCF (dry)	0.70
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	85.0
Oil in Gas**, Vol % RSFA	0.3
Oil in Spent Shale, Vol % RSFA	0.0
Total Oil Meas., Vol % RSFA	85.3
Carbonate Decomposition, %	27.9
Water Recovered, lb/ton RS	68.1
Ash Balance, % - As Measured	—
Ash Balance, % - Assumed	R.S. 100
Overall Balance, %	98.9
Carbon Balance, % - Organic	91.6
Carbon Balance, % - Total	94.5
Hydrogen Balance, % - Organic	89.3
Hydrogen Balance, % - Total	91.4
Water Balance, %	92.1
MISCELLANEOUS	
Avg. Retort ΔP, in H_2O/ft	0.33
ΔP Above Air Dist., in H_2O/ft	0.32
NaCl Soln., Wt %	—
NaCl Rate, gal/ton RS	—

Comments: Line burner temperature surging — Reduced line burner temperature to reduce dilution burning, also reduced dilution air and increased recycle to help reduce the burning and surging.

*Measured Recycle + Dilution Gas

** Oil Mist + Condensibles to 83 °F

*** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Earl E. [illegible] DATE July 17, 1967

OSRC-10
Revised 7/19/66

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//A100
2080, C1046-3 R-1 6-20-67

A. YIELDS
FAY      8.497E 01    DRYGAS   6.347E 03    MISTFA   2.743E-01
H2       3.364E 02    OTHER    1.016E 02    UNRETO   0.0
CH4      1.269E 02    O2       3.173E 01    SSY      8.165E 01
CO       1.904E 02    CO2DEC   2.790E 01    MH2O     6.806E 01
CO2      1.542E 03    OILCOL   2.388E 01

B. METERED GAS RATES
RECG     1.081E 04    DIL      1.950E 03    WVENTG   6.382E 03
AIR      5.078E 03    TRECG    1.276E 04    TGF      0.0

C. MOL WT & HEATING VALUE OF VENT GAS
MWWG     2.930E 01    HVGT     6.081E 02    MWDG     3.056E 01
GBTU     9.581E 01

D. COMBUSTION PRODUCTS
CO2C     6.590E 02    COC      1.720E 02    H2OC     2.789E 01
CHR      8.416E 00    COMBCP   1.005E 01

E. MATERIAL IN
ORGCIN   2.621E 02    RSR      3.021E 02    ORH2IN   3.308E 01
MATIN    2.417E 03

F. MATERIAL OUT
ORGCVG   4.611E 01    COKEC    3.638E 01    UNRETH   0.0
ORGCOL   1.555E 02    ORH2VG   7.635E 00    COKEH    1.372E 00
UNRETC   0.0          ORH2OL   2.052E 01    ORCOLP   5.932E 01
ORCVGP   1.836E 01    ORCSSP   1.388E 01    HCCVGP   8.304E 00

G. MATERIAL BALANCES
OVALL    9.891E 01    ORH2     8.925E 01    O2BAL    9.897E 01
ASH      0.0          TC       9.454E 01    WATER    9.209E 01
ORGC     9.156E 01    TH2      9.138E 01    GASL     6.759E 02
ASH8    -1.000E 00

H. HEAT IN
QCOMB    4.767E 05    QH2OC    1.053E 04    QAIR     5.237E 03
QPROP    3.998E 01    QOILC    1.294E 04    QRCYL    4.915E 04
QSUMIN   5.546E 05

I. HEAT OUT
QMCO2D   1.546E 05    QKEROD   1.032E 05    QH2OV    5.035E 04
QLIQO    3.878E 03    QOFGAS   2.330E 04    QSS      2.185E 05
QGASL    8.117E 03    LBLOSS   0.0          HETLOS  -7.365E 03
QSUMOT   5.546E 05

J. MISCELLANEOUS
ORCSS    2.228E 00    VPOIL    9.403E-02    TGL      2.892E 03
VPM      5.328E 00    WCG      1.007E 01    PROP     1.518E 01

END MESSAGE


END OUTPUT
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HEAT AND MATERIAL BALANCE FOR PILOT RETORTS - DATA SHEET

LINE #	PROGRAM ID	USER IDENTIFICATION					
0	2080,	C1046-3 R4 6-20-67					
	WRS	OLRS	TRS	B	MRS		RAW SHALE
1	1.0	10.7	81	-1	16680.5		
	FA	GRS	CORS	XA			
2	28.1	2.2	17.1	55.22			
	ASRS	CRS	HRS	BP	TOG		
3	67.2	17.7	1.75	24.3.6	138		
	CRA	MFA	TA	PA	WA	LBHL	AIR
4	706.9	1.0	137	129	0.14	0	
	CRRG	MFRG	TRG	PRG	CRTG	MFTG	RECYCLE AI TOTAL GAS
5	1512.5	1.0	265	76	0.0	0.0	
	CRDG	MFDG	TDG	PDG			DILUTION G.
6	5.88	56.4	271	76			
	P	TP	PP	W	N		PROPANE AI NUCLEATIN AGENT
7	2.43	0.4	128.7	211.1	0.0		
	WSS	OLSS	GSS	SS			SPENT SHALE
8	0.5	0.0	0.0	0.0			
	COSS	ASSS	CSS	HSS	TSS		
9	15.1	82.3	6.35	0.14	636		
	OILLP	COL	HOL	DOL	WLP		LIQUID PRODUCT
10	1541.8	84.1	11.1	7.742	165.1		
	CRVG	MFVG	TVG	WG	OILM	M	VENT GAS
11	1227.6	1.0	271	0.0	0.0	0	
	CG	H	COOG	OG	NG		
12	11.6	0	24.3	0.5	63.3		
	MEG	COG	HHG	OTG	HG		
13	2.0	3.0	5.3	1.6	0.70		
	CRVP	VPMF	TVP	PVP			VENT PURGE
14	4.3	2.17	159	47			
	TVPC	VPOIL	VPW	GL			
15	83	38.1	2.8	82.5			

OPTIONS:

1. *B Enter "1" to Calculate with Spent Shale Rate and Ash Analyses,*
   Or "0" to Calculate with Measured Rates,
   Or "-1" to Calculate with Raw Shale Rate and Ash Analyses.
2. *M Enter "1" to Calculate with Measured Moisture and Mist,*
   Or "0" to Calculate from Vent Purge Data.
3. *H Enter "1" to Calculate using Retort #2,*
   Or "0" to Calculate using Retort #3.

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-20-67 Run No. C 1046-3

Sample Time: RS 1815 ; SS 2315

FISCHER ASSAY

(X) RAW SHALE	(X) SPENT SHALE	
27.8	0.0	Gal/Ton
.914	.	S.G., g/ml
10.6	0.0	Oil, wt %
2.2	0.5	Water, wt %
85.0	99.4	Sp. Shale, wt %
2.2	0.1	Gas & Loss, wt %
slight	none	COKING TENDENCY

( ) RETORT SHALE MOISTURE

Est. 1.25 wt %

Rx (X) RAW SHALE FISCHER ASSAY MOISTURE

1.23 wt %

MINERAL CO_2

(X) 17.0 (X) 15.1 wt %

ASH (SHALE)

(X) 66.9 Rx (X) 82.3 wt %

MOISTURE

Rx (X) 0.39 Rx (X) 0.16 wt %

( ) SHALE RICHNESS DISTRIBUTION (See attached graph)

CARBON

(X) 17.6 ~~17.2~~ (X) 6.35 wt %

(X) SCREEN ANALYSIS (See back of this sheet)

HYDROGEN

(X) 1.74 (X) 0.14 wt %

17.6
4.64
12.96

BENZENE EXTRACTABLES

( ) . ( ) . wt %

All results are "as received" unless noted. "Moisture" designates the moisture content of the -48 mesh material used for "Ash", "Mineral CO_2", "Carbon", and "Hydrogen". The "FA Moisture" is for the sample used for the Fischer Assay. 11.8-12.

COMMENTS

DATE COMPLETED JUN 24 1967 CHECKED BY RCP

OSRC 104

MESH	WT GRAMS	WT %
8	143.8	22.1
14	197.0	30.3
28	118.8	18.3
35	48.1	7.4
48	33.8	5.2
65	30.6	4.7
100	27.3	4.2
150	20.0	3.1
PAN	30.2	4.7
TOTAL	649.6	100.0%

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-20-67 Run No. C1046-3 (2100)

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
WATER, wt %	1.6	/	/	/		
GRAVITY, °API	20.7	/		/		
OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g 457.0

WATER VOL, ml 68.0

GRAVITY OIL, °API 39.8°

VENT GAS

MAJOR COMPONENTS

CO_2	24.3	vol %
O_2	0.5	"
N_2	62.5	"
CH_4	2.0	"
CO	3.0	"
H_2	5.3	"
Ar	0.3	"
Others	1.6	"

C_1 thru C_4, plus n-Pentane

CH_4	.	vol %
C_2H_4-C_2H_6	.	"
C_3H_8	.	"
C_3H_6	.	"
i C_4H_{10}	.	"
n C_4H_{10}	.	"
$\not{o}C_3H_6$	.	"
n C_5H_{12}	.	"

CARBON, 11.6 lbs/MSCFDG

HYDROGEN, 0.70 lbs/MSCFDG

COMMENTS

JUN 22 1967

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C-1016-3 SAMPLE NO. _____ DATE 6-20-67

UNIT Retort 3 DESCRIPTION Ty Zone 1

APPROX. SHALE SIZE ¼-2½ SHAKING TIME 10 min ANALYSIS BY Schultz Sons

TOTAL SAMPLE WT. GROSS 87.5 – TARE 6.6 = NET 80.9

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50		22.4	16.7	5.7
	2.00		42.9	20.2	22.7
	1.50		41.9	23.4	18.4
	1.05		34.9	19.1	15.6
	0.742		28.8	20.5	8.3
	0.525		23.5	18.5	5.0
	0.371		20.4	19.2	1.2
	0.263	3	20.3	18.4	1.9
	0.185	4	19.7	19.4	.3
	0.131	6	19.4	19.3	.1
	0.093	8	20.1	20.1	.0
	0.065	10	19.3	19.2	.1
	PAN		21.7	21.0	.7
TOTAL ON SCREENS AND PAN					80.0
LOSS (BY DIFFERENCE)					.1
TOTAL SAMPLE WEIGHT					80.1

SCREEN SIZE	Di *	1/Di	% RETAINED	CUM. % RETAINED	% PASSING
4.25					
3.00	(3.125)	(0.3200)			100.00
2.50	(2.625) 2.750	(0.3809) 0.3636	7.13		92.91
2.00	2.250	0.4444	28.38		64.53
1.50	1.750	0.5714	23.00		41.53
1.05	(1.087) 1.275	(0.9199) 0.7843	19.50		22.03
0.742	0.896	1.116	10.38		11.65
0.525	0.634	1.577	6.25		5.40
0.371	0.448	2.232	1.50		3.90
0.263	0.317	3.154	2.38		1.52
0.185	0.224	4.464	0.38		1.14
0.131	0.158	6.329	0.13		1.01
0.093	0.112	8.928	0.00	99.03	1.01
0.065			0.13		0.88
PAN			0.88		0.00
LOSS			—	—	—
TOTAL			100.04	—	—
			—	—	—

* NUMBERS IN PARENTHESES SHOULD BE USED WHEN THESE SCREEN SIZES REPRESENT THE TOP OF THE SHALE SIZE RANGE.

$\Sigma^{m}_{+8m} Di$	1.6279	$\Sigma^{m}_{+8m} Xi$	
$1/\Sigma^{m}_{+8m} Di$	0.78578	$\Sigma^{m}_{+8m} Xi / Di$	
Da	1.2602	$\Sigma^{m}_{+8m} Xi\ Di$	
Dv	1.640%		

REMARKS: _____

OSRC-4